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April 1986

TR EL-82-4

Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (Pacific Southwest)

SPINY LOBSTER

Fish and Wildlife Service
U.S. Department of the Interior

Coastal Ecology Group
Waterways Experiment Station
U.S. Army Corps of Engineers

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SPINY LOBSTER

by

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PREFACE

This species profile is one of a series on coastal aquatic organisms, principally fish, of sport, commercial, or ecological importance. The profiles are designed to provide coastal managers, engineers, and biologists with a brief comprehensive sketch of the biological characteristics and environmental requirements of the species and to describe how populations of the species may be expected to react to environmental changes caused by coastal development. Each profile has sections on taxonomy, life history, ecological role, environmental requirements, and economic importance, if applicable. A three-ring binder is used for this series so that new profiles can be added as they are prepared. This project is jointly planned and financed by the U.S. Army Corps of Engineers and the U.S. Fish and Wildlife Service.

Suggestions or questions regarding this report should be directed to one of the following addresses.

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CONVERSION TABLE

Metric to U.S. Customary

Multiply	By	To Obtain
millimeters (mm)	0.03937	inches
centimeters (cm)	0.3937	inches
meters (m)	3.281	feet
kilometers (km)	0.6214	miles
square meters (m^2)	10.76	square feet
square kilometers (km^2)	0.3861	square miles
hectares (ha)	2.471	acres
liters (l)	0.2642	gallons
cubic meters (m^3)	35.31	cubic feet
cubic meters	0.0008110	acre-feet
milligrams (mg)	0.00003527	ounces
grams (g)	0.03527	ounces
kilograms (kg)	2.205	pounds
metric tons (t)	2205.0	pounds
metric tons	1.102	short tons
kilocalories (kcal)	3.968	British thermal units
Celsius degrees	1.8(°C) + 32	Fahrenheit degrees

U.S. Customary to Metric

inches	25.40	millimeters
inches	2.54	centimeters
feet (ft)	0.3048	meters
fathoms	1.829	meters
miles (mi)	1.609	kilometers
nautical miles (nmi)	1.852	kilometers
square feet (ft^2)	0.0929	square meters
acres	0.4047	hectares
square miles (mi^2)	2.590	square kilometers
gallons (gal)	3.785	liters
cubic feet (ft^3)	0.02831	cubic meters
acre-feet	1233.0	cubic meters
ounces (oz)	28.35	grams
pounds (lb)	0.4536	kilograms
short tons (ton)	0.9072	metric tons
British thermal units (Btu)	0.2520	kilocalories
Fahrenheit degrees	0.5556(°F - 32)	Celsius degrees

CONTENTS

	Page
PREFACE	iii
CONVERSION TABLE	iv
ACKNOWLEDGMENTS	vi
NOMENCLATURE/TAXONOMY/RANGE	1
MORPHOLOGY/IDENTIFICATION AIDS	1
REASON FOR INCLUSION IN SERIES	2
LIFE HISTORY	3
Spawning	3
Larval Stage	3
Postlarvae and Juveniles	4
Maturity and Life-Span	4
GROWTH CHARACTERISTICS	5
COMMERCIAL AND SPORT FISHERIES	5
Commercial Fisheries	5
Sport Fisheries	7
ECOLOGICAL ROLE	7
ENVIRONMENTAL REQUIREMENTS	8
LITERATURE CITED	9

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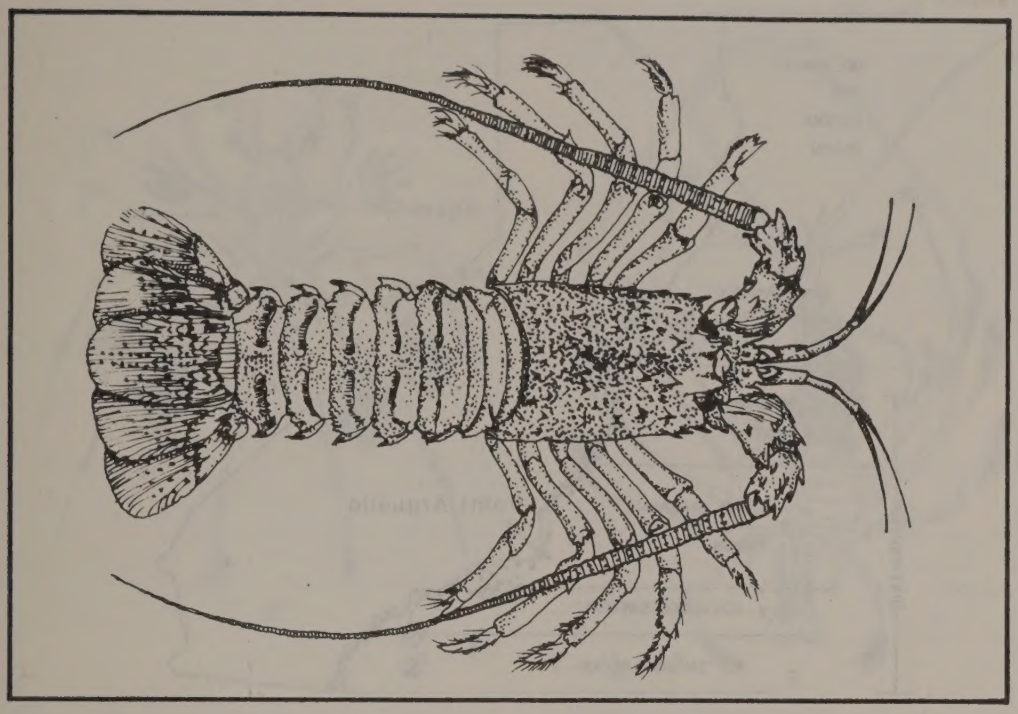

Figure 1. Spiny lobster.

SPINY LOBSTER

NOMENCLATURE/TAXONOMY/RANGE

Scientific name.....Panulirus interruptus (Randall)
Preferred common name...Spiny lobster (Figure 1)
Other common names.....Rock lobster, red lobster
Class.....Malacostraca
Order.....Decapoda
Family.....Palinurida

Geographic range: Coastal waters of the Pacific Southwest, from Monterey Bay, California, to Magdalena Bay on the west side of South Baja California, Mexico (Figure 2). A relatively isolated population inhabits the northern waters of the Gulf of California (Duffy 1973). This lobster is most abundant in the coastal waters of central Baja California (Lindberg 1955; Johnson 1960). The southern range of the spiny lobster overlaps the northern range of the pinto lobster, P. inflatus (Wilson 1947).

MORPHOLOGY/IDENTIFICATION AIDS

The peduncle of the antennules is slightly longer than that of the antennae; first segment about as long as the next two; flagella longer than the peduncle, the outer setose on one side except near the base. Peduncle of the antennae armed with short,

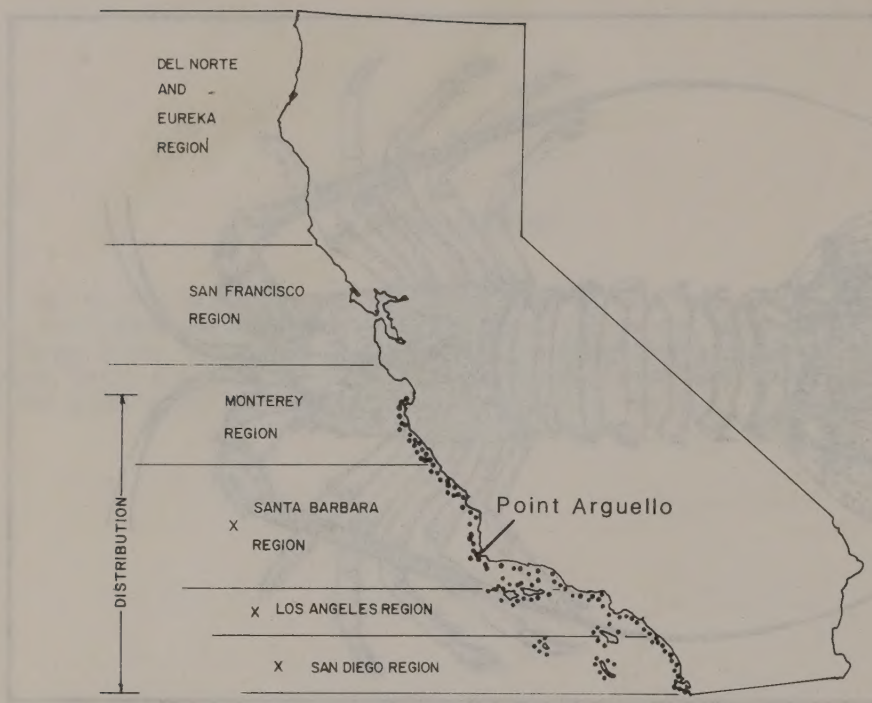

Figure 2. Distribution of the spiny lobster along the California coast. Map taken from Bureau of Marine Fisheries (1949).

stout spines, flagella spinulous, compressed at the base, and exceeding the body in length. Abdominal segments furnished with a pair of transverse dorsal setose sulci, which do not meet at the midline except indistinctly on the sixth segment. Carapace lengths to 60.9 cm (Schmitt 1921).

Color in life: Walking leg vittate alternately red and olivaceous. Color widely varied, ranging from almost black through shades of dark mahogany and reddish purple to light red. Larval stages, or phyllosomas (Figure 3), are characterized by their transparent dorsoventrally flattened bodies and long fragile legs (Johnson 1956).

REASON FOR INCLUSION IN SERIES

The spiny lobster along the southern California coast supports a valuable commercial and sport fishery. In the early 1970's, lobster abundance declined sharply--as the fishery increased, local stocks declined and the fishery spread to more distant grounds (Odemar et al. 1975). In addition to heavy fishing pressure, the loss of lobster habitat from coastal development and severe fishing restrictions have lowered commercial production. Inasmuch as lobsters live in rocky coastal waters, any change in

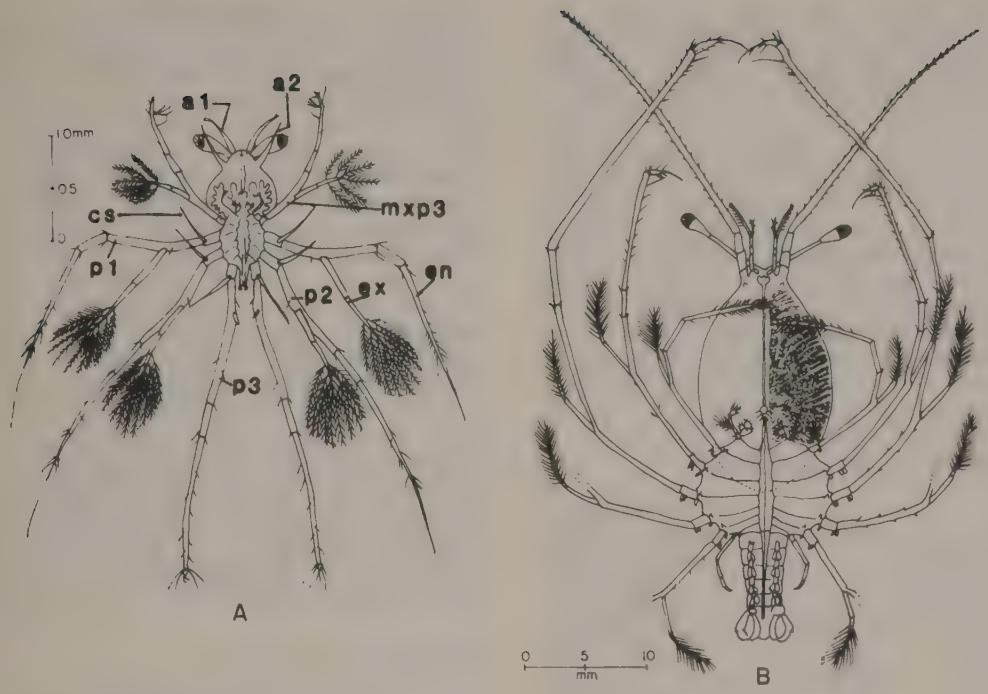

Figure 3. Stage I (A) of Panulirus interruptus phyllosoma hatched in an aquarium: a1, first antenna; a2, second antenna; cs, coxal spine; en, endopod; ex, exopod; mxp, third maxilliped; p1, p2, p3, first, second, and third legs. Stage XI (B) of Panulirus interruptus phyllosoma (from Johnson 1956).

the environment by humans would probably reduce lobster abundance.

LIFE HISTORY

Spawning

The spiny lobster spawns from March to August, but primarily from May through July (Allen 1916). Mating takes place in water 50 to 100 ft deep, from December through March. The male deposits a tar-like spermatophore on the sternum of the female. The female then moves inshore (to water less than 30 ft deep) and extrudes 50,000 to 800,000 eggs. They are fertilized by sperm released from the spermatophore and become attached to her pleopods. Development of the eggs is completed in 9 to 10 weeks. The eggs, coral red when first released, change to deep maroon before hatching.

Larval Stage

The larvae pass through 11 pelagic phyllosoma stages (Johnson 1956). The body of the larva is highly transparent and dorsoventrally compressed. According to Johnson (1956), the body length of the larva is about 1.4 mm at Stage I (Figure 3A) and about 29 mm at Stage XI (Figure 3B). Less than 3% of the larvae live to reach Stage XI (Johnson 1956). In southern California, especially in the Channel Islands area, seasonal development of countercurrents, gyres,

and eddies may be essential for successful inshore recruitment because they offset the southward and seaward drift caused by the California Current (Johnson 1960).

Phyllosome larvae are extremely difficult to rear in captivity. High mortalities are probably due to nutrient deficiencies (Dexter 1972). Although Dexter (1972) was able to raise lobster only to Stage VI, he estimated that it would take 5 months for the larvae to reach Stage XI in the laboratory. In the open sea it takes 7 to 9 months for the larvae to reach Stage XI (Johnson 1956).

Postlarvae and Juveniles

At Stage XI the phyllosomas metamorphose to the puerulus stage. The animal is still transparent but structurally similar to the adult, except that the second antennae are three times the body length (Johnson 1956). The puerulus stage lasts about 2.5 months. The pueruli exhibit a strong positive phototactic response and can be lured to a bright underwater light at night (Serfling and Ford 1975a). Pueruli are commonly found in floating habitats consisting largely of surf grass, Phyllospadix torreyi. The influx and settlement to the bottom of pueruli larvae in inshore waters are continuous from May through September. Little is known about their food habits (Frey 1971). Once settled on the bottom, the pueruli become fully pigmented in 6 to 8 days. They molt in 9 to 11 days and become benthic juveniles.

Spiny lobsters have been successfully cultured from pueruli through the juvenile stages in water temperatures of 22 and 28 °C (Serfling and Ford 1975b). The average monthly increase in carapace length was 3.3 mm at 22 °C and 4.5 mm at 28 °C. (All lengths refer to carapace lengths unless otherwise indicated.) These growth rates, under controlled conditions, were about two to three times greater than those estimated for pueruli in southern California coastal waters. Apparently the higher water temperatures in the experiment increased molting rates.

Aquaculture of lobsters under controlled water temperatures may be feasible if enough pueruli or post-puerulus stages could be located and removed without seriously reducing the abundance of natural populations. It may be possible to culture pueruli (7 mm carapace length, CL) to legal size (83 mm) in about 2 years at 28 °C, and 3 years at 22 °C (Serfling and Ford 1975b). In contrast, it takes 7 years for lobsters to reach legal size in southern California coastal waters. Because of the relative scarcity of pueruli in these waters, however, attempts to capture adequate numbers for culture would not be practical (Serfling and Ford 1975a).

Maturity and Life Span

About 50% of the females 66 mm long and about 90% of those 69 mm long or longer are sexually mature. The smallest berried female was 63 mm long and was 6 years old. Age at sexual maturity usually is 3 to 6 years for males and 5 to 9 years for females.

The sexes of spiny lobsters and the maturity of females can be distinguished by anatomical characteristics. The genital orifice is at the base of the third pair of pereiopods in the female but at the base of the fifth pair in the male. Mature females are recognized by the small chela at the extreme end of the fifth pereiopod and by enlarged pleopods with rod-like endopodites bearing filaments for the attachment of eggs (Lindberg 1955).

The life span of mature spiny lobsters is difficult to determine because all hard body parts are shed periodically.

GROWTH CHARACTERISTICS

Although the age and growth of adults has not been accurately determined, it is known that the carapace length of juveniles increases about 3.1 mm after each molt. Juveniles reach 24 mm after 1 year and 44 mm after 2 years. Legal-size animals (83 mm long) molt once a year (Backus 1960).

After settling to the bottom, males growing at average rates reach the minimum legal length after 7 to 10 years and females after 12 years.

In one study (Odemar et al. 1975), annual growth increments ranged from 4.8 to 1.3 mm for females 50 to about 104 mm long, and from 5.6 to 1.5 mm for males 50 to 112.5 mm long. These measurements indicate that males grow faster than females (Odemar et al. 1975).

In another study (Mitchell et al. 1969), however, the length of males increased from 51 to 88 mm in 10 molts, an annual increment of 3.7 mm, whereas females increased from 56 to 91 mm in eight molts, an annual increment of 4.4 mm. These data indicate that females grew faster than males.

The differences in growth between the two sexes as determined in the two studies (Mitchell et al. 1969; Odemar et al. 1975) could have been caused by sampling bias or maybe by real differences.

COMMERCIAL AND SPORT FISHERIES

Commercial Fisheries

Most spiny lobsters landed in the United States (a different species, P. argus) come from Florida waters. In 1982, total U.S. landings of spiny lobsters was 6.4 million pounds valued at $16.2 million. Florida's catch was 5.8 million pounds, or 91% of the total; these landings were worth $14.1 million, or 87% of the total (Thompson 1983).

Although California's landings are relatively small, the spiny lobster is an important commercial species in southern California.

A record of the commercial landings in California from 1916 to 1982 (Table 1) shows that the annual catch was relatively stable from 1916 to 1945 (Bureau of Marine Fisheries 1949), averaging slightly over 300,000 pounds. From 1946 to 1956, the average annual catch was 775,000 lb. After 1956 the catch declined to a low of 190,000 lb in 1974. The decline was attributed to three factors (Odemar et al. 1975): (1) illegal taking of undersized lobsters; (2) increase in the sport catch; and (3) loss of habitat due to environmental change, largely caused by urban coastal development.

The commercial catch of spiny lobsters was 560,966 pounds in 1978 and annual catches from 1979 to 1982 exceeded 300,000 lb. The estimated 1982 catch was 600,000 lb valued at $2.1 million. The reasons for the sudden increase in annual catch are unclear.

The California commercial fishing grounds for spiny lobsters extend from Point Arguello in southern California, south through the Channel Islands to the Mexican border (Figure 2). Fishing is at depths of 2 to 55 m, or wherever rocky bottoms or kelp beds are abundant. According to Odemar et al. (1975), along the California coast there are about 81,000 acres of lobster habitat, 90% of which is fished commercially.

Lobsters are caught in rectangular, box-like traps covered with 11-gage wire mesh. Each trap is buoyed (with permit number) for retrieval. The traps are lifted every 24 to 48 h along the mainland coast, and every 48 to 96 h around the

Table 1. Yearly landings (lb) of spiny lobster in California, 1916-82 (Duffy 1973; Odemar et al. 1975; Thompson 1983).

Year	lb	Year	lb
1916	250,632	1950	933,449
1917	355,259	1951	824,611
1918	195,750	1952	807,070
1919	256,894	1953	749,245
1920	247,156	1954	901,293
1921	334,271	1955	855,416
1922	376,310	1956	735,869
1923	384,381	1957	647,281
1924	294,356	1958	632,618
1925	432,059	1959	505,947
1926	442,198	1960	351,032
1927	508,123	1961	412,453
1928	355,800	1962	515,816
1929	396,764	1963	584,192
1930	374,450	1964	446,655
1931	383,697	1965	480,325
1932	319,307	1966	489,088
1933	380,014	1967	449,874
1934	366,651	1968	312,483
1935	371,661	1969	309,472
1936	414,183	1970	225,399
1937	393,242	1971	224,486
1938	308,378	1972	398,217
1939	376,928	1973	233,179
1940	281,102	1974	190,950
1941	357,334	1975	201,412
1942	168,641	1976	292,534
1943	298,377	1977	251,568
1944	512,490	1978	560,966
1945	478,619	1979	378,000(est.)
1946	690,272	1980	345,000(est.)
1947	593,401	1981	-------
1948	563,520	1982	600,000(est.)
1949	834,658		

islands. Fishing is conducted mostly from skiffs 6 m long or less, although a few of the boats (9%) are longer than 9 m (Odemar et al. 1975).

Lobster traps must have an escape port 51 mm in diameter that allows small lobsters to escape. The catch ratio of illegal and legal sized lobsters in 1973-74, before the introduction of the escape port, was 5.4:1. For 1976-77, when the escape port was mandatory, the ratio dropped to 0.8:1 (Odemar et al. 1975).

In California, up to 19,000 traps are fished annually but less than 5,000 are used at any one time. Most fishermen set about 100 traps, although a few set as many as 500 traps (Odemar et al. 1975).

The lobster business is partly dependent on the availability of bait for the traps. In recent years, over 300 tons of bait have been used per season. Small fish or the heads and frames of bonito and anchovy are used for bait. Black abalone are used as bait in the Channel Islands.

The fishing season begins on the first Wednesday in October and extends through the first Wednesday after March 15. Fishing intensity and catch are highest in the early part of the season. About 36% of the lobsters are caught in October alone, compared with only 6% in March. The major lobster boat landings are between Encinitas and San Diego and among the San Clemente Islands. About 60% of the annual catch in the 1973-74 season was landed in these areas (Odemar et al. 1975).

After capture, live lobsters are held in "live" boxes and anchored in kelp beds until a load is obtained. The catch is sold mainly to wholesale dealers, who also supply the bait (Odemar et al. 1975).

Lobster fishermen sell about 81% of their catch to wholesalers, 9% to restaurants, and 7% to private parties; 3% are retained for their own use. Lobsters are marketed alive or frozen. They can be safely shipped alive in crates for as long as 24 h after packing (Odemar et al. 1975).

Commercial fishing for lobsters has its problems. In some areas,

particularly the San Clemente Islands, predation by the California sheepshead (Senicossyphus pulcher) is severe, and frequent servicing of traps (pots) is necessary to reduce loss (Odemar et al. 1975). Traps are robbed by boaters, surfers, and other fishermen. The large-scale catch and sale of undersize lobsters have been a major factor in the decline of lobster abundance for many years. Although a 2-inch escape port is required in the pots, many undersized lobsters are still caught and kept. Nevertheless, it has been recommended that the port be increased to 1-7/8 inches x 3-7/8 inches (Odemar et al. 1975). Because pots often are lost at sea, many trapped lobsters are lost. Traps should have an area that self-destructs so that lobsters can eventually escape from lost pots.

Sport Fisheries

Sportsmen often seek spiny lobsters and sometimes take large numbers of them. Although there are few data on the sport catch, it may equal half of the commercial catch (Frey 1971).

Most lobsters are taken by skin divers and scuba divers, although some sportsmen use hoop nets. Many fishermen catch "shorts" (undersized lobsters) and cook and eat them before returning to the mainland.

Many people fish off party boats and the number of diver days from these boats has been increasing. There were 275 diver days (one person fishing for 5 h) in the 1958-59 lobster season but 15,871 in the 1973-74 season (Odemar et al. 1975). There is a clear need for better statistics on the annual sport catch.

ECOLOGICAL ROLE

The feeding habits of spiny lobsters change as they grow and mature. As larvae they feed on plankton, although the taxonomic groups in their diet are unknown. In the laboratory, lobster larvae can be raised up to the sixth phyllosome using Artemia nauplii for food. Successful rearing of spiny lobsters through all larval stages will be possible only after suitable foods are found (Dexter 1972).

For juvenile spiny lobsters, the most common foods are mollusks, algae, sponges, hydroids, polychaetes, crustaceans, and sea urchins. In the laboratory, juveniles were successfully maintained to the puerulus stage on diced trimmings of abalone (Serfling and Ford 1975b). When available, squid, fish flesh, juvenile crabs, and limpets were also used for food in the laboratory.

Mature animals are omnivorous and primarily scavengers. They feed at night by combing through clumps of bushy algae, digging in soft sediments, or feeding on attached organisms. Before dawn they return to the same reef or den, where they have been known to stay as long as 10 months (Lindberg 1955).

The behavior of spiny lobsters becomes more specific as they grow from phyllosome larvae to adults. Although spawning occurs in deep waters, the larvae settle out in the shallow coastal waters. As juveniles they live under the protection of plant cover such as surf grass, southern sea palms, bushy brown algae, and large-bladed brown algae. As adults they live in crevices or dens. Up to several hundred lobsters sometimes live in one den (Engle 1979).

The spiny lobster has a number of predators, mainly octopuses (Pycnopodia sp.), California sheephead, cabezon (Scorpaenichthys marmoratus), kelp bass, sharks, and moray eels. Predation on young

lobsters is common but is negligible on adults (Engle 1979).

A potential danger to the spiny lobster is the sea otter (Enhydra lutris). Now distributed in coastal waters from Avila, San Luis Obispo County, to Ano Nuevo, San Mateo County, it is rapidly expanding its range. Studies on the effects of sea otters foraging on inshore macroinvertebrates have shown that in some areas otters reduce the abundance of such animals as abalone, crabs, clams, and sea urchins to levels so low that sport and commercial fishing for these species is no longer practiced (Odemar et al. 1975).

The merit of introducing the American lobster (Homarus americanus) in southern California coastal waters was considered by Krekorian et al. (1974). They theorized that because of the dominant behavioral interaction of the American lobster over the spiny lobster in the laboratory, similar behavior could be expected in their natural habitat. The authors concluded that it would not be advisable to introduce American lobsters into southern California waters.

ENVIRONMENTAL REQUIREMENTS

Useful studies on the environmental requirements of the spiny lobster are scarce. Studies of growth related to temperature (Serfling and Ford 1975b) have been restricted to the laboratory. Serfling and Ford (1975a) found growth in the laboratory at temperatures between 22 and 28 °C to be three times faster than in southern California coastal waters where temperatures fluctuate between 15 and 22 °C. Other major studies on environmental requirements in recent years include the habitat of the puerulus larval stage (Serfling and Ford 1975a; Engle 1979).

Since California is on the northern fringe of the spiny lobster range, density-independent conditions (e.g., current patterns and temperature extremes) affecting recruitment and juvenile survival probably are more limiting than in more southern coastal waters. Because of the increasing fishing pressure on a steadily declining stock of spiny lobsters, it is becoming increasingly urgent that the ecological requirements of the puerulus and juvenile stages be studied. On the basis of such information, it may be possible to protect or enhance the natural habitat of the lobsters during their early life stages.

Pueruli first enter coastal waters near San Diego in May and continue to appear regularly through September. Their movement has no apparent relationship to lunar or temperature cycles (Serfling and Ford 1975a). The importance of surf grass as a nursery for juvenile lobsters in southern California is clearly apparent (Serfling and Ford 1975a; Engle 1979) and the disturbance or destruction of it could seriously decrease lobster abundance.

Because of its high price and high demand, the spiny lobster is a likely candidate for experimental mariculture; but judging by the present knowledge of this species, prospects are poor. The lobster has a long and complicated larval life. The food requirements for some larvae stages are not known, the growth rate is slow, and large-scale collections of pueruli for mariculture and restocking are not likely to be made (Serfling and Ford 1975b).

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13. Type of Report & Period Covered

14.

15. Supplementary Notes
*U.S. Army Corps of Engineers Report No. TR EL-82-4

16. Abstract (Limit: 200 words)

Species profiles are summaries of the literature on taxonomy, morphology, distribution, life history, and environmental requirements of major coastal aquatic species, which are prepared to assist in environmental impact assessment. The spiny lobster (Panulirus interruptus) supports a valuable commercial and sport fishery along the southern California coast. Mating takes place from March to August in water 50 to 100 ft deep. The larvae pass through 11 pelagic stages in 7 to 9 months. The puerulus stage lasts another 2.5 months before the lobster transforms into the benthic form. Age at sexual maturity is 3 to 6 years for males and 5 to 9 years for females. Spiny lobsters are caught in commercial traps from October through March. Sport fishing for lobsters is mainly done by skin divers and scuba divers. Juveniles live in shallow coastal waters under the protection of plant cover; adults live in crevices or dens. Larvae are plankton feeders and adults are omnivorous, primarily scavengers. Because of a scarcity of information on larval food requirements and the slow larval growth rate, profitable mariculture of the spiny lobster currently is not feasible.

17. Document Analysis a. Descriptors
Lobsters
Life cycles
Growth
Feeding habits

b. Identifiers/Open-Ended Terms
Spiny lobster
Panulirus interruptus
Commercial fishery
Sport fishery
Ecological requirements

c. COSATI Field/Group

18. Availability Statement
Unlimited release

19. Security Class (This Report) Unclassified

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22. Price

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